A Special AHARS Lecture Presentation

by

Professor Mike Underhill, G3LHZ

Titled

Impossible Antennas and Impossible Propagation!

Friday 13th September 2013 at 7.30 PM to 9.30 PM (including Q&A time) + Supper

Venue: St. Andrews Church Hall, 43 Church Terrace, Walkerville

Content outline of the Talk:

- **What does 'impossible' mean?** – In theory? In practice?
- **Thermal Efficiency** – the common-sense measure for antennas. Does the (small) antenna get hot or self-destruct? (**'First Law of Thermodynamics'** = conservation of energy and power.)
- **Antenna Effectiveness** – is it an antenna with good propagation on transmit or good Signal-to-Noise-Ratio (SNR) on receive?
- **How do we discover new antennas and new modes of propagation?** – We follow Archimedes. **Experiment**→ Concept→ Theory→ Mathematics→ Simulation→ Design→ Make→ Optimisation by **Experiment**. Radio amateurs are experimenters!
- **The Inductance of Small Loops of all Shapes and Sizes.** Demo measurements. **RSS (root-Sum-of-the Squares) combining** of inductance components is discovered to be essential.
- **Ground Assessment with Small Loops** – (EM) coupling found to be a maximum of $\kappa = 1/2\pi$. This is of fundamental importance. Demo of basic Ground Assessment.
- **Optimum Small Tuned Loop Design** – not too big and not too small. Small Loops do not scale! Use of two or more modes.
- **Optimum Antenna Conductor Size.** – An active spreadsheet will be shown.
- **The Impossible Loop-Monopole opens our eyes**. Eureka! It will be demonstrated.
- **How Antennas Transmit *and Receive*. –** It is the coupling that transmits *and receives*. The coupling forms a lens around the antenna.
- **Low Noise Receive Antennas –** what has to be done?
- **The Discovery of 'Anomalous Wave Tilt' –** Impossible propagation?
- **The Coupled Transmission Line Model of all Electromagnetics, Antennas and Propagation –** is all the theory we need for the future?
- **Simple Plotting of Antenna Patterns –** using FunCubePro, will be demonstrated.
- **The Future of Simulation for all Electromagnetics, Antennas and Propagation is 'Analytic Region Modelling' (ARM)? –** Examples for long wires, large loops and effects of lossy ground on antenna patterns will be shown.

Brief Bio for Prof Mike Underhill, G3LHZ

The formal (boring) stuff: Was Chairman and Research Director, Toric Ltd, UK for 10 years until its closure in 2010 and is currently CEO, Underhill Research Limited (Scientific Research Services).

Mike's long industry career was mostly with Philips, where his major roles included Director of the Systems Division at Philips Research Laboratories, Redhill, and Technical Director at MEL, Crawley. For over 25 years, Mike has been an advisor to the Ministry of Defence in a variety of roles, centrally through the Defence Science Advisory Council, but also through DSTL. He currently is lead UK assessor on a joint UK/US program, the 'ITA Consortium' that was recently (in March 2012) praised on The White House website. Mike has also enjoyed a long academic career, and has been associated with the University of Surrey at Guildford UK for over 40 years, of which 13 years were in full time employment as Professor of Electronics, Head of EE Department, and Dean of Engineering. Currently he lectures at the University of Surrey on Short Courses in Radar, RF, Microwaves, and Antennas and Propagation. He is a longstanding contributor to the European Frequency and Time Forum (EFTF).

He has been involved in Defense Electronics (mainly HF Radio) since 1961 and EW and Radar and IR since 1980 and more recently Military Information Systems. His research interests still include low phase noise in oscillators and frequency synthesis, low jitter sources. His present research focus is on fundamental electromagnetics, antennas, and propagation, including HF transmitting loops, passive OTH HF radar and passive ionospheric sounding. He regularly gives papers at PIERS (Progress In Electromagnetic Research Symposium) and other conferences such as the 2013 Radar conference in Adelaide! He holds about 50 patents and has published about eighty papers. He has been a Fellow of the Royal Academy of Engineering since 1993.

The amateur radio (fun) stuff:

Mike was first licensed and became a member of the RSGB in 1956, and has been active ever since. He was a founder member of the Crawley Amateur Radio Club in 1957. Last year (with Derek G3GRO) he was a winning 23cm band operator in the 2012 VHF National Field Day.

Mike has written on HF transmitting loop antennas for RSGB and ARRL publications including the specially commissioned article titled "The Truth about Loops" in the International Antenna Collection Handbook which gave an in-depth account of the much maligned small loop. Mike did have a book on the subject of small loop antennas envisaged for publication in 2008. But as the result of a substantial amount of novel and ground-breaking research, much of which is to be reported in this talk, this book has been superseded by a proposed book to be called "Effective Antennas".

There has been raging debate and technical comment on the efficacy of small loops in the RSGB's publication *RadCom* over the years, including in Pat Hawker's widely read column up to the time of his retirement and recent regrettable Silent Key status. His book 'A bit of controversy' refers to this. In Mike's view the professional antenna experts have driven themselves into a pessimistic theoretical cul-de-sac with regard to small antenna performance. This lecture will explain and demonstrate why. Mike's views seem to have got his name and all reference to his publications banned from one antenna forum, which he takes as a compliment and an endorsement of the novelty of his pioneering work!

Prof Mike Underhill MA, PhD, FREng, FIET, MIEEE, FRSA, MRSGB (chair of UK panel)

Mike Underhill received an MA in Physics at Oxford in 1960 and a PhD in Electronics at Surrey in 1972 (thesis: Control of Focused Electron Beams for Microcircuit Manufacture). He became a Fellow of the Royal Academy of Engineering (FREng) in 1993; belonged to FIET (FIERE and then FIEE) since 1982 and MIEEE since 2002; and has been a Fellow of the Royal Society of Arts (FRSA) since 1992. He is a member of the RSGB and has been an active radio amateur for over 50 years.

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